

CLAIMS

What is claimed is:

1. A method for enzymatically degrading lignocellulose comprising the steps of:
 - 5 (a) subjecting an aqueous mixture containing lignocellulose with ultrasound; and
 - (b) contacting the mixture with a cellulase under conditions sufficient for hydrolysis.
- 10 2. The method according to Claim 1 wherein said aqueous mixture of step (a) further comprises said cellulase.
3. The method according to Claim 2 wherein said cellulase is provided by a cellulase-producing microorganism in said aqueous mixture.
- 15 4. The method according to Claim 2 wherein said step (a) is continuous.
5. The method according to Claim 2 wherein said step (a) is discontinuous.
- 20 6. The method according to Claim 1 wherein said ultrasound is conducted at a frequency of between about 2 and 200 kHz.
7. A method for enzymatically degrading lignocellulose comprising the steps of:
 - 25 (a) subjecting an aqueous mixture containing lignocellulose with ultrasound; and
 - (b) contacting the mixture with a cellulase and ethanologenic microorganism under conditions sufficient for hydrolysis.

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8. The method according to Claim 7 wherein said aqueous mixture of step (a) further comprises said cellulase and ethanologenic microorganism.
- 5 9. The method according to Claim 8 wherein said cellulase is provided by a cellulase-producing microorganism in said aqueous mixture.
10. The method according to Claim 8 wherein said step (a) is continuous.
- 10 11. The method according to Claim 8 wherein said step (a) is discontinuous.
12. The method according to Claim 8 wherein said ultrasound is conducted at a frequency of between about 2 and 200 kHz.
- 15 13. The method according to Claim 8 wherein said ethanologenic microorganism is an ethanologenic bacteria or yeast.
14. The method according to Claim 13 wherein said ethanologenic microorganism is a bacteria or yeast which expresses one or more enzymes which,
20 individually or together, convert a sugar to ethanol.
15. The method according to Claim 13 wherein said ethanologenic microorganism expresses enzymes which, individually or together, convert pentose and hexose to ethanol.
- 25 16. The method according to Claim 13 wherein said ethanologenic microorganism expresses alcohol dehydrogenase and pyruvate decarboxylase.

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17. The method according to Claim 16 wherein said alcohol dehydrogenase and pyruvate decarboxylase are from *Zymomonas mobilis*.
 - 5 18. The method according to Claim 13 wherein said ethanologenic microorganism expresses xylose isomerase, xylulokinase, transaldolase, and transketolase.
 - 10 19. The method according to Claim 18 wherein said xylose isomerase, xylulokinase, transaldolase, and transketolase are from *Escherichia coli*.
 20. The method according to Claim 18 wherein said xylose isomerase, xylulokinase, transaldolase, and transketolase are from *Klebsiella oxytoca*.
 - 15 21. The method according to Claim 18 wherein said xylose isomerase, xylulokinase, transaldolase, and transketolase are from *Erwinia* species.
 - 20 22. The method according to Claim 13 wherein said ethanologenic microorganism expresses alcohol dehydrogenase, pyruvate decarboxylase, xylose isomerase, xylulokinase, transaldolase, and transketolase.
 - 25 23. The method according to Claim 22 wherein said ethanologenic microorganism is a recombinant microorganism expressing *Zymomonas mobilis* alcohol dehydrogenase and pyruvate decarboxylase wherein said microorganism is selected from the group consisting of *Escherichia coli*, *Klebsiella oxytoca*, and *Erwinia* species.

24. The method according to Claim 23 wherein said
ethanologenic microorganism is *Klebsiella oxytoca* P2.
25. The method according to Claim 23, wherein said
ethanologenic microorganism is *Escherichia coli* KO11.

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